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(54) BY-PASS OR BRIDGING CONDUCTOR OF INFINITELY VARIABLE LENGTH

(71) We, BROWN, BOVERI & CIE, AKTIENGESELLSCHAFT, of 6800 Mannheim 1, Postfach 351, Germany, a German Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a phase shifting device for a symmetrical transmission line in the short-wave range, such as a wave range of 10 to 100 metres.

Where two collinear transmitting dipoles are provided, in which both radiating elements are supplied symmetrically, that is to say with phase coincidence, from a single source of current, the resulting radiation diagram of the electric field radiated in the horizontal direction is obtained in the form of two mirror-symmetrical main lobes and four secondary lobes, with the dipole disposed in the axis of symmetry of the horizontal radiation diagram and the longitudinal axes of the two main lobes extending at right angles to the axis of the dipole. The inphase supply of the two radiating elements is obtained by means of a connecting lines of equal length between the source of current and the two elements. When the length of one of the two connecting lines is changed, the supply current I_1 on this connecting line changes in relation to the supply current I_2 on the other connecting line to the extent of a phase angle δ resulting from the ratio of the change in the length of the connecting line to the transmitted wave length. As far as the radiated field is concerned, this phase displacement δ between the two supply currents I_1 and I_2 implies that the main lobes are turned through a corresponding angle—generally referred to as an "angle of squint or strabism"—from the symmetrical zero position.

In transmission engineering, it is frequently desirable that the horizontal direction of the radiated electrical field should be variable within a determined range of angle of strabism, the change in the length of the connecting line required for this purpose being brought about with the aid of variable phase shifting devices. Such variable phase shifting devices for coaxial lines are described on pages 389 and 390 of "Taschenbuch fuer Hochfrequenztechnik" by Meinke-Grundlach, Springer-Verlag, Berline, Goettingen, Heidelberg. In one of the known phase shifting devices used for feeding symmetrical aerials through coaxial lines, the by-pass conductor is of a telescopic construction similar to that of a trombone, whereas in another known construction, the variable by-pass conductor consists of an annular slotted coaxial conductor along which a rotatable pick-up extends.

It is thus the object of the invention to create for the short-wave range a variable phase shifting device which has a considerably larger angle of strabism while its physical dimensions are nevertheless sufficiently limited to enable it to be installed in a fixed housing affording its protection against atmospheric influences.

According to the invention there is provided a differential phase shifting device comprising first and second generally U-shaped electrical conductors each having telescopic leg sections and means for connecting each U-shaped conductor in series with a respective transmission line and a mechanical coupling of insulating material between the two U-shaped conductors whereby, in use, a reduction in length of one conductor results in a corresponding increase in length of the other conductor.

Each U-shaped conductor may comprise two fixed sections arranged substantially parallel to each other and two sections telescopically slideable with respect to the two fixed sections.

The U-shaped conductors are advantageously incorporated in a fixed housing.

In a further development of the inven-

tion, the housing contains juxtaposed pairs of interconnected U-shaped conductors.

The U-shaped conductor sections are advantageously guided on insulating spring rollers secured to the bottom of the housing.

The displacement of the telescopic conductor sections may also be brought about by cable pulls which are driven by controllable motors.

The invention is hereinafter described with reference to the drawings, in which:—

Figure 1 shows a basic circuit diagram;

Figure 2 is a longitudinal section through a housing containing two by-pass conductors.

The reference numerals used in the drawings are as follows: 1 and 2 denote symmetrical connecting lines of a branched transmission system whose sections 1', 1'' and 2' 2'' respectively extend to the radiating elements 3 and 4 of an antenna; 5 denotes a supply source of current, 6 and 7 denote infinitely variable telescopic U-shaped conductors of a phase shifting device and 8 denotes a partition in the front part of a housing 9; 10, 11 and 12 denote sections of the U-shaped conductors 6 and 7 having a base section 13; 14 denotes a partition provided in the rear part of the housing 9; 15 denotes a mechanical coupling member of insulating material, 16 is a displaceable partition of an insulating material, 17 insulating spring rollers, 18 a driving motor, 19 a cable pull and 20 the pulleys used for guiding the cable pull.

It will be noted from Figure 1 that variable conductors 6 and 7 are respectively provided in the symmetrical connecting lines 1 and 2 between the radiating elements 3, 4 and the source of current 5. Each conductor divides the respective connecting line into two sections 1', 1'' and 2', 2'' respectively. As illustrated the section 1', 1'' of the connecting line 1, the internally hollow, insulated ends of the sections are passed through the partition 8 provided in the front part of the housing 9. The variable conductor 6 between the said two ends also consists of internally hollow conductor sections 10, 10', 11, 11', and 12, 12', the last two conductor sections 12, 12' being electrically conductively interconnected by the base section 13. The electric length of the conductor 6 is changed by telescopic displacement of the conductor sections 10, 11, 12 and of the conductor sections 10', 11' and 12', a similar telescopic displacement into the hollow ends of sections 1, 1' of the connecting line being additionally possible.

Similarly the section 2', 2'' of the connecting line 2, the internally hollow, insulated ends of the sections are passed through the partition 14 provided in the rear part of the housing 9. The variable conductor 7 between the said two ends also consists of internally hollow conductor sections 10, 10', 11, 11' and 12, 12' the two last conductor sections 12, 12' being electrically conductively interconnected by the base section 13. The electric length of the conductor 7 is changed by telescopic displacement of the conductor sections 10, 11, 12 and of the conductor sections 10', 11' and 12', a similar telescopic displacement into the hollow ends of sections 1, 1' of the connecting line 1 being additionally possible. Insulating spring rollers 17 by which the remaining conductor sections 10, 10', 11, 11' and 12, 12' are guided and supported, are provided at the bottom of the housing 9. The displacement of the conductor sections 10, 10', 11, 11' and 12, 12' is obtained by means of a controllable driving motor 18 through a cable pull 19 which is passed over guide rollers 20 and secured to the jumper 13 and to the displaceable partition 16.

It will be readily appreciated that a displacement of this telescopic conductor system by a determined amount results in the electrical length of the conductor being changed to an extent of twice that amount. By means of this telescopic conductor system, it is thus possible to reduce the absolute length of the conductor by half the amount obtainable in the known phase shifting devices for the short-wave length, while the change in electric length is the same as that obtained by the known phase shifting devices. The two U-shaped conductors 6, 7 are interconnected by the displaceable partitions 16 to form an arrangement, in which a shortening of the conductor 6 results in a lengthening of the conductor 7, and conversely.

As far as the phase displacement between the currents I_1 and I_2 is concerned, this implies that a displacement of the U-shaped conductors by a determined amount results in a phase displacement corresponding to four times the amount of this change in length. Thus, when a change in the electric length of, for example, 40 metres is required for a determined angle of strabism, the U-shaped conductors need only carry out a stroke of a length of 10 metres for this purpose.

Where an aerial installation comprises a substantial number of dipoles each of which is supplied in the manner illustrated in Figure 1, an equally substantial number of juxtaposed pairs of interconnected U-shaped conductors may be provided in the same housing. Since the juxtaposed telescopic conductors are provided relatively closely together, the overall dimensions of a phase shifting device of this kind are many times smaller than those of the known devices

used for the short-wave range. These small overall dimensions make it possible to provide the conductors in a housing in an economically justifiable manner and thus to prevent any occurrence of trouble due to atmospheric influences.

WHAT WE CLAIM IS:—

1. A differential phase shifting device comprising first and second generally U-shaped electrical conductors each having telescopic leg sections and means for connecting each U-shaped conductor in series with a respective transmission line and a mechanical coupling of insulating material between the two U-shaped conductors whereby, in use, a reduction in length of one conductor results in a corresponding increase in length of the other conductor.

2. A phase shifting device according to claim 1, wherein each U-shaped conductor comprises two fixed sections arranged substantially parallel to each other and two sections telescopically slideable with respect to the two fixed sections.

3. A phase shifting device according to claim 1 or claim 2, wherein the U-shaped conductors are in a fixed housing.

4. A phase shifting device according to claim 3, in which interconnected pairs of the U-shaped conductors are provided side by side in the housing.

5. A phase shifting device according to claim 1, 2, 3 or 4, in which the U-shaped conductor sections are guided on insulating spring rollers secured to the bottom of the housing.

6. A phase shifting device according to any one of claims 1 to 5, in which cable pulls driven by controllable motors are provided for the displacement of the telescopic sections.

7. A phase shifting device substantially as hereinbefore described with reference to and as illustrated in Figure 2 of the accompanying drawings.

8. A branched symmetrical transmission system comprising two transmission lines having a common source of radio frequency energy, and a phase shifting device according to any one of the preceding claims, wherein each U-shaped conductor of the device is in series with a respective transmission line.

9. An installation substantially as hereinbefore described with reference to and as illustrated in Figures 1 and 2 of the accompanying drawings.

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1314693 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

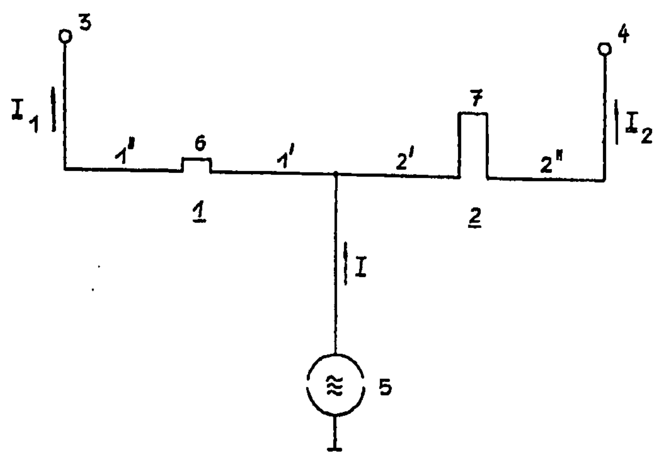

Fig. 1

1314693 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 2

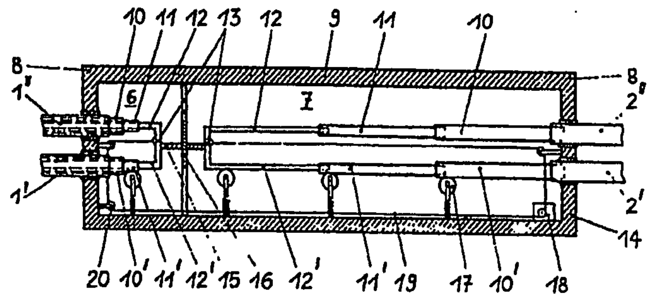

Fig.2